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Evidence for temporal and spatial variations in groundwater contaminant plume discharge to a stream

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The pollution and impairment of stream waters by chemical compounds is one of the threats currently targeted by the enforcement of the EuropeanWater Framework Directive in Denmark. The groundwater/surface water interaction is one the pathways for the release of contaminant in streams. In this study, a 2D advection-dispersion model associated to field measurements was used to investigate the mixing and dilution of pollutants discharging from a groundwater plume to a stream at different times of the year. The model is a continuation of the work by Aisopou et al. (2015) which simulates the mixing of groundwater pollutant plumes seeping into a stream. Extra features such as drains or sewers can also be accounted for as additional point sources in the adapted model presented here, as well as the dilution effect of tributaries to better simulate the possible urbanization of streams. The model was used to characterize a plume of chlorinated compounds that discharges into a small stream at a former industrial site in Raadvad, Denmark (Average stream width: 10 m; average flow: 300 l/s; contaminant mass discharge: ca. 1 kg/y). The simulation was combined with streambed and surface water sampling, as well as monthly flow rate monitoring and groundwater fluxes. The use of the model facilitated the identification of a possible discharge area of the groundwater plume and successfully captured the evolution of the pollutant concentration and mixing. At the time of measurement, the groundwater plume seeped mostly through a narrow area of the streambed, which was confirmed by high concentration results from the streambed water sampling and identification of an upward groundwater flux into the stream. The measurements and simulations carried out at later times of the year revealed the existence of temporal and spatial variations: 1) in the overall quantity of chlorinated compound discharged, 2) in the discharge pathways with additional contribution from a drain, and 3) in the contaminant mixing itself. The results highlight the complexity and variability of the contaminant fluxes at the interface between a groundwater contaminated plume and stream water, and the need for a better understanding of the general dynamics of these fluxes.

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References

Aisopou, A., Bjerg, P. L., Sonne, A. T., Balbarini, N., Rosenberg, L., and Binning, P. J. *Dilution and volatilization of groundwater contaminant discharges in streams*. Journal of Contaminant Hydrology (2015), 172, p.71-83.